



Engineering, Test & Technology
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Sonic Boom Prediction Workshop III FUN3D Mesh Adapted Results

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Overview

Flow Solver and Computing Platform

Summary of Cases and Grids

Flow Solver Convergence

Results: Biconvex 9x7 Shock-Plume Interaction Model

Results: C608 Low Boom Flight Demonstrator Model

Flow Solver and Computing Platform

Flow Solver

- FUN3D version 13.3
- Finite-volume, RANS with SA turbulence model

Biconvex 9x7 Shock-Plume Interaction Model

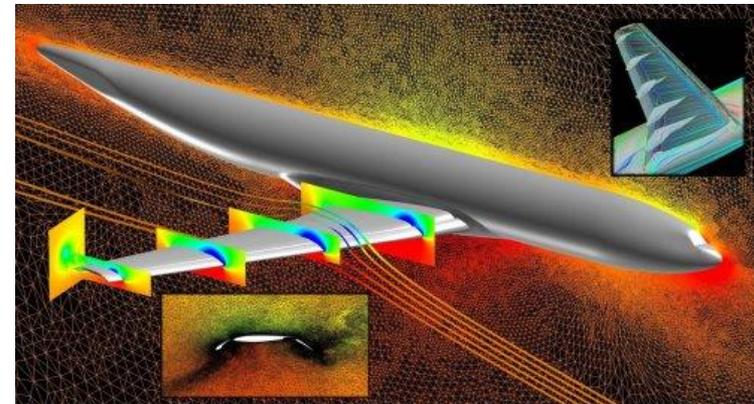
- van Leer limiter (only first 1000 iterations)
- CFL ramp [1, 10] in first 500 iterations
- CFL_t = 1 throughout (to avoid divergence)
- 2000 solver iterations
- Model region initialized with subsonic Mach number

C608 Low Boom Flight Demonstrator Model

- van Leer limiter (only first 1000 iterations)
- CFL ramp [1, 10] in first 500 iterations
- 5000 solver iterations
- Model region initialized with subsonic Mach number

Computing Platform

- MPI parallelization, distributed memory
- Typical resource allocation per case: 15 Nodes
- 40 Intel Xeon CPUs / node with 178 GB onboard memory



<https://fun3d.larc.nasa.gov/index.html>

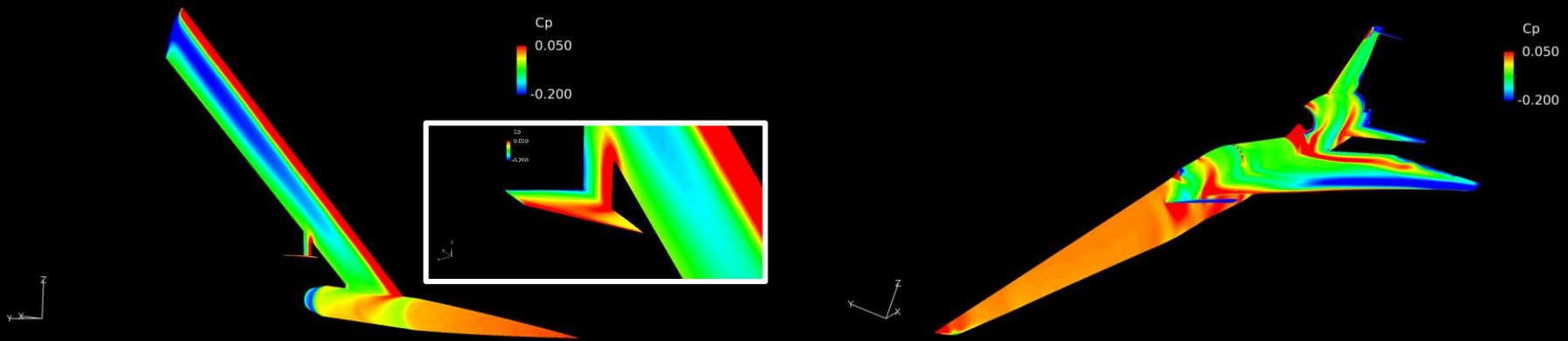
Summary of Cases and Grids

Biconvex 9x7 Shock-Plume Interaction Model

- FUN3D with feature-based and output-based adaptation
- Initial tetrahedral viscous grid: [biconvex-visc-tet-157.b8.ugrid](#)
- 4,785,786 tetrahedra

C608 Low Boom Flight Demonstrator Model

- FUN3D with feature-based and output-based adaptation
- Initial tetrahedral viscous grid: [c608-visc-tet-128.b8.ugrid](#)
- 68,486,582 tetrahedra



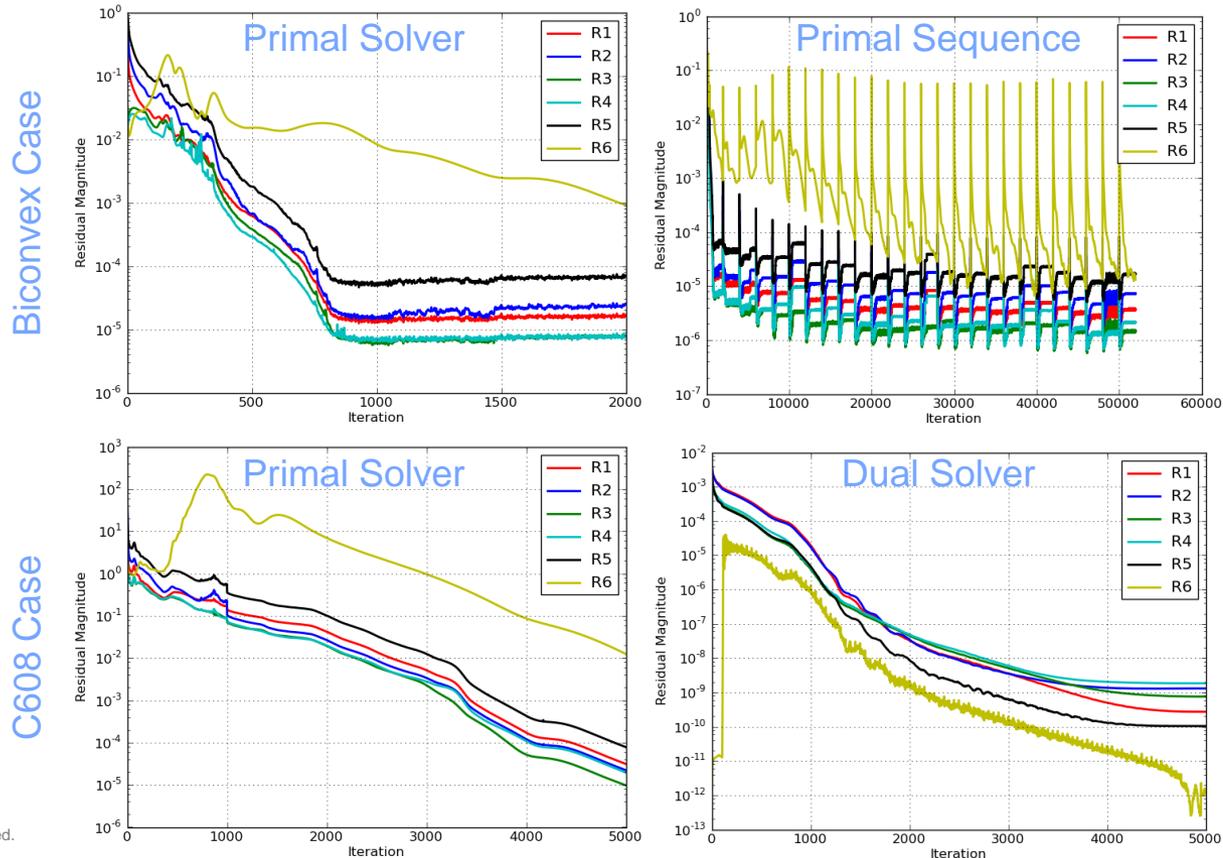
Flow Solver Convergence

Biconvex 9x7 Shock-Plume Interaction Model

- Typical primal solver convergence (state and turbulence) with limiter “ringing”
- Low CFL_t needed to avoid divergence of R6 throughout mesh adaptation sequence

C608 Low Boom Flight Demonstrator Model

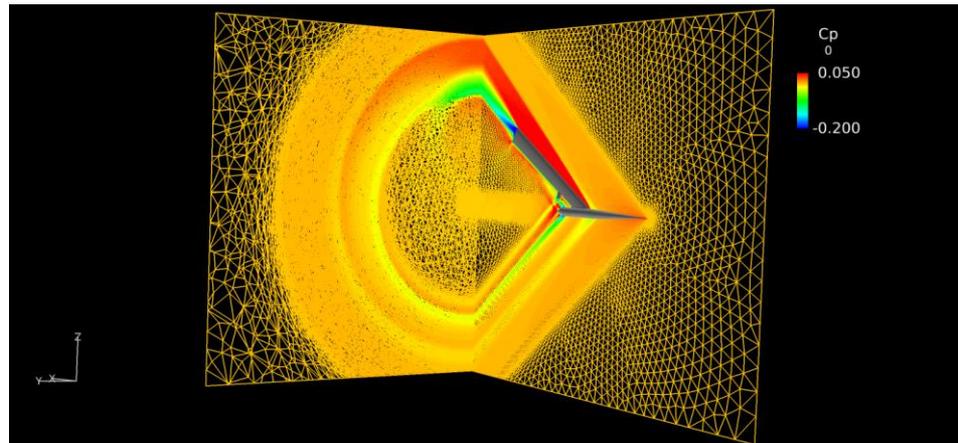
- Typical well-behaved primal and dual solver convergence (state and turbulence)



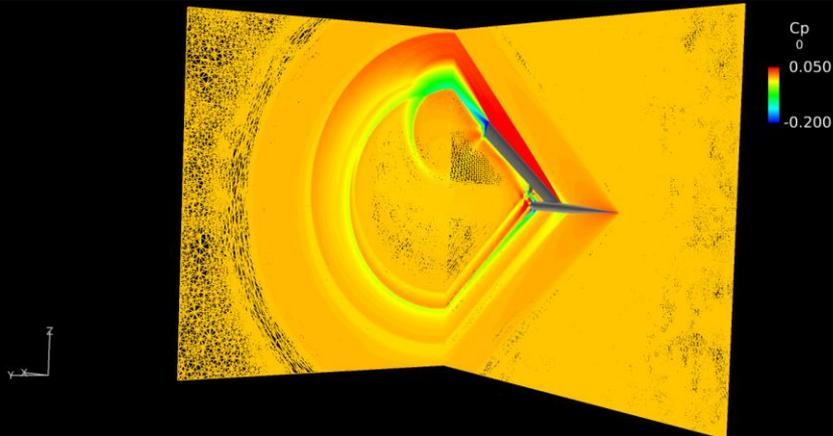
Results: Biconvex 9x7 Shock-Plume Interaction Model

Domain Pressure Contours

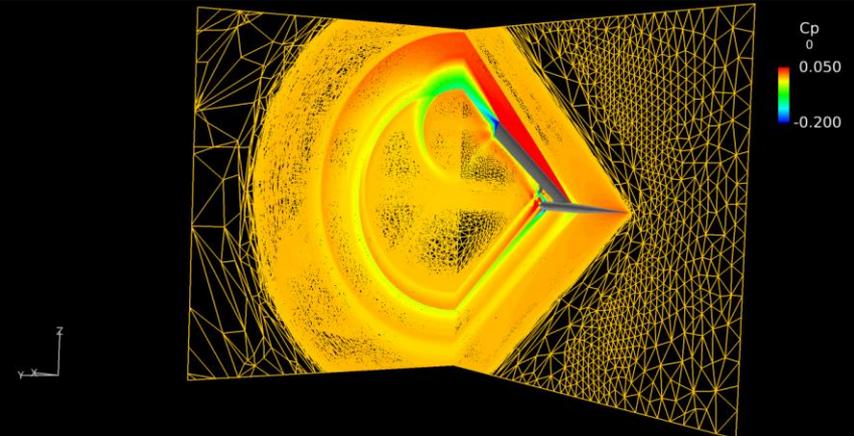
Initial Grid



Feature-Based
Mesh 25



Output-Based
Mesh 14

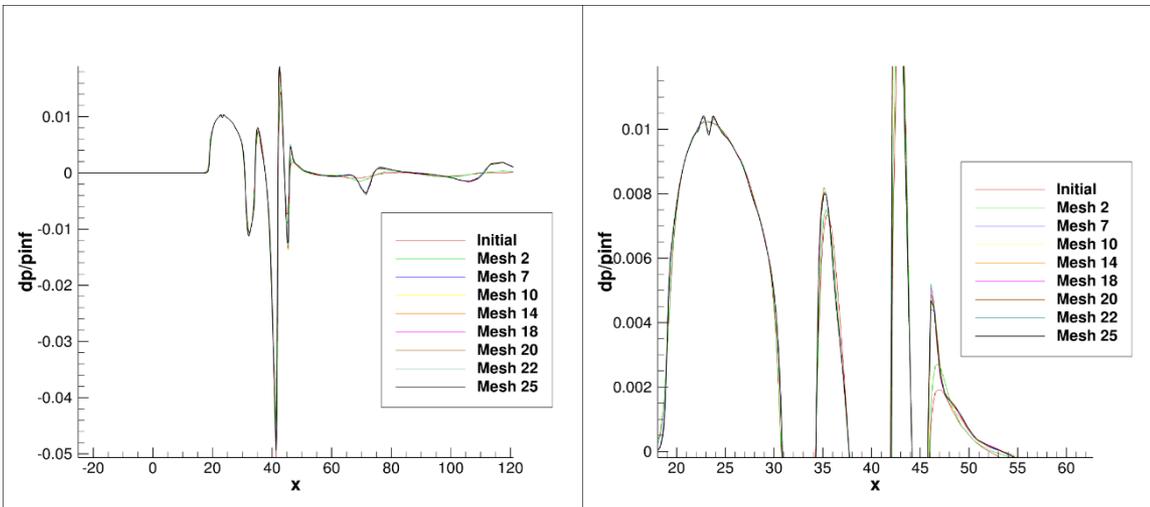


Results: Biconvex 9x7 Shock-Plume Interaction Model

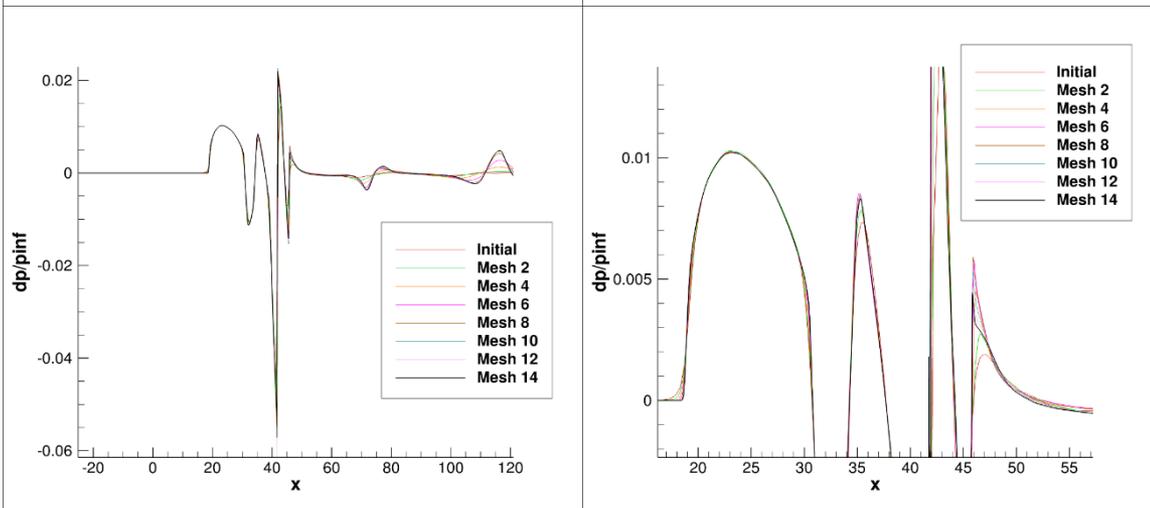
Near-field Pressure Signatures

- 25 feature- and 14 output-based adapted meshes

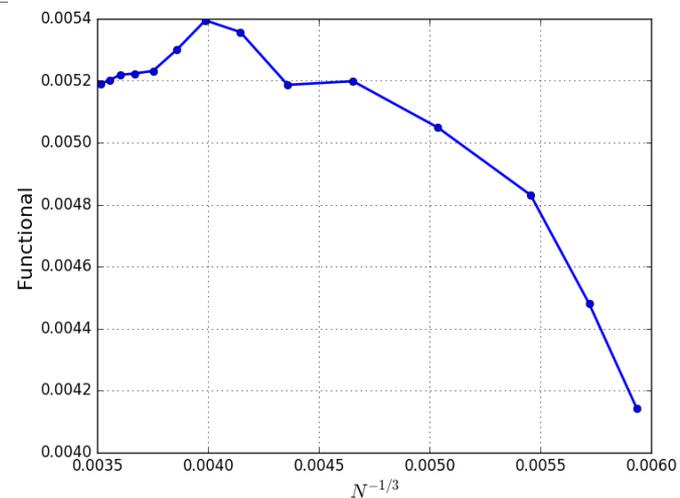
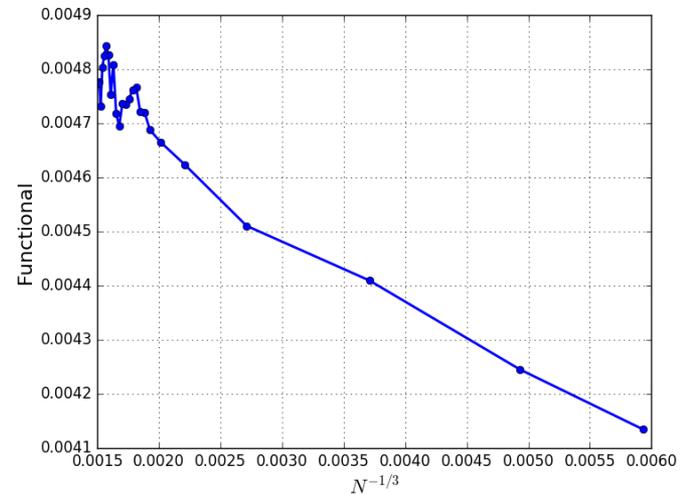
Feature-Based



Output-Based



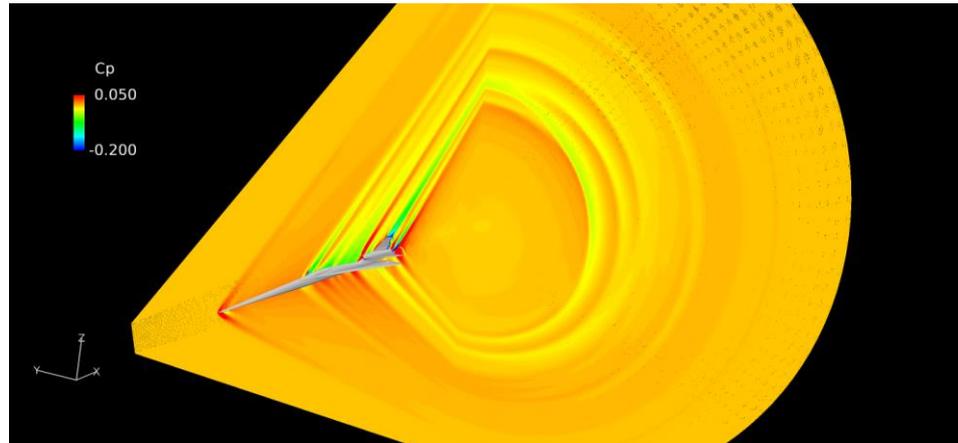
Functional Grid Convergence



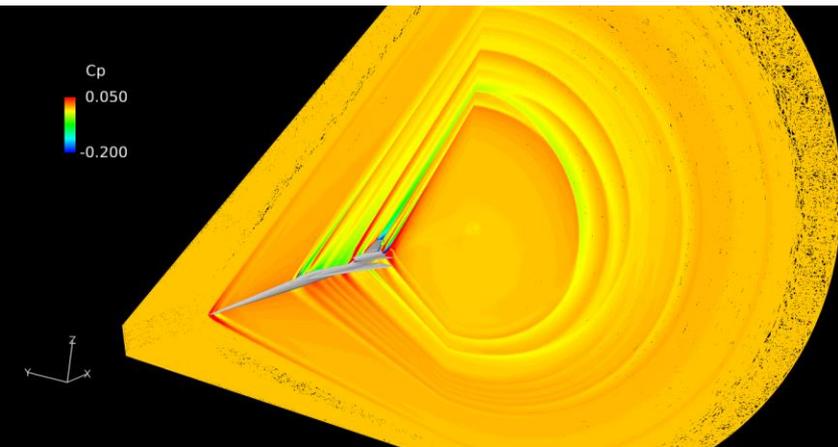
Results: C608 Low Boom Flight Demonstrator Model

Domain Pressure Contours

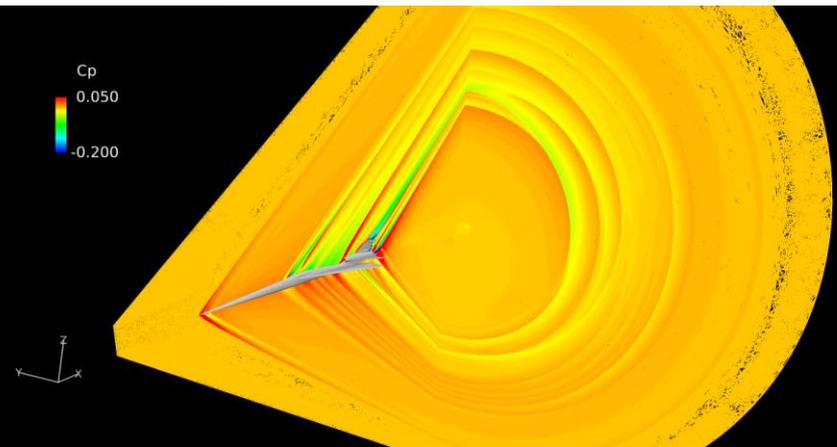
Initial Grid



Feature-Based
Mesh 3



Output-Based
Mesh 4

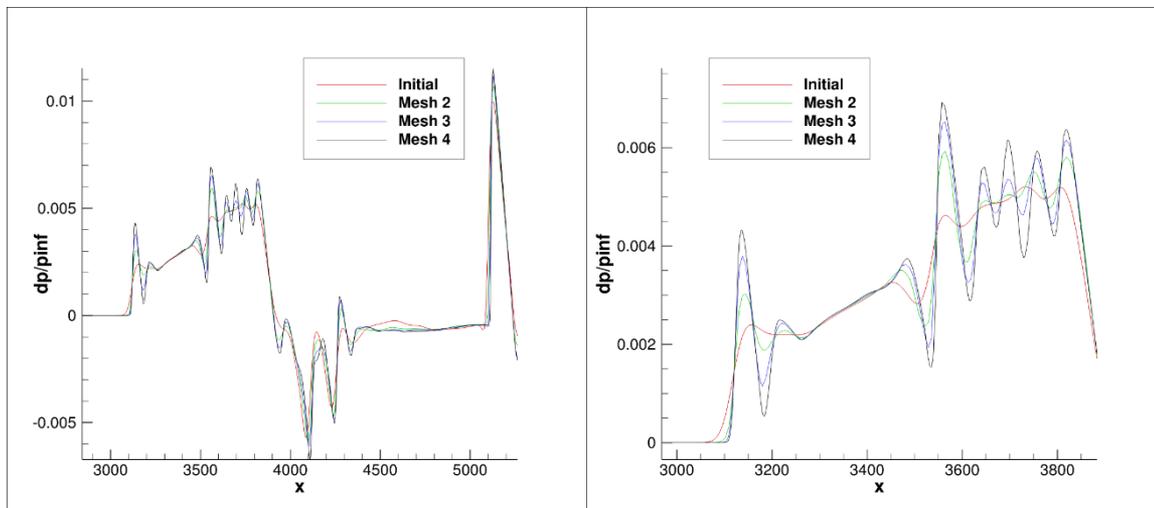


Results: C608 Low Boom Flight Demonstrator Model

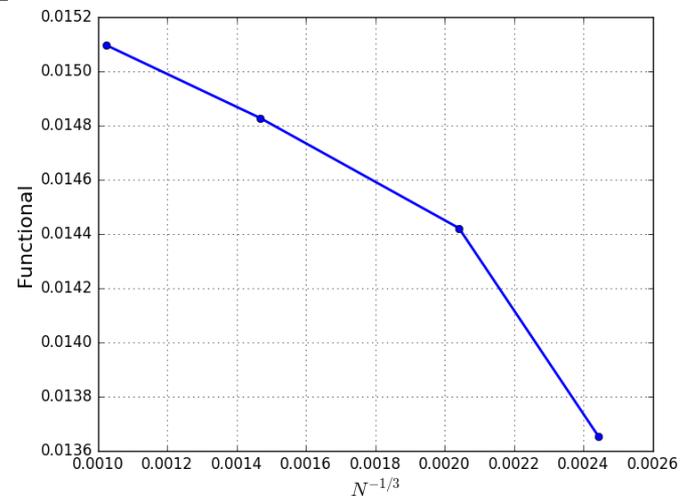
Near-field Pressure Signatures

- 4 feature- and output-based adapted meshes

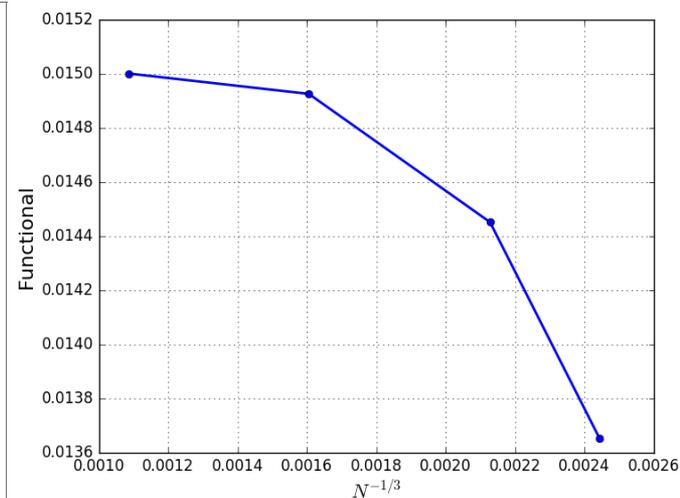
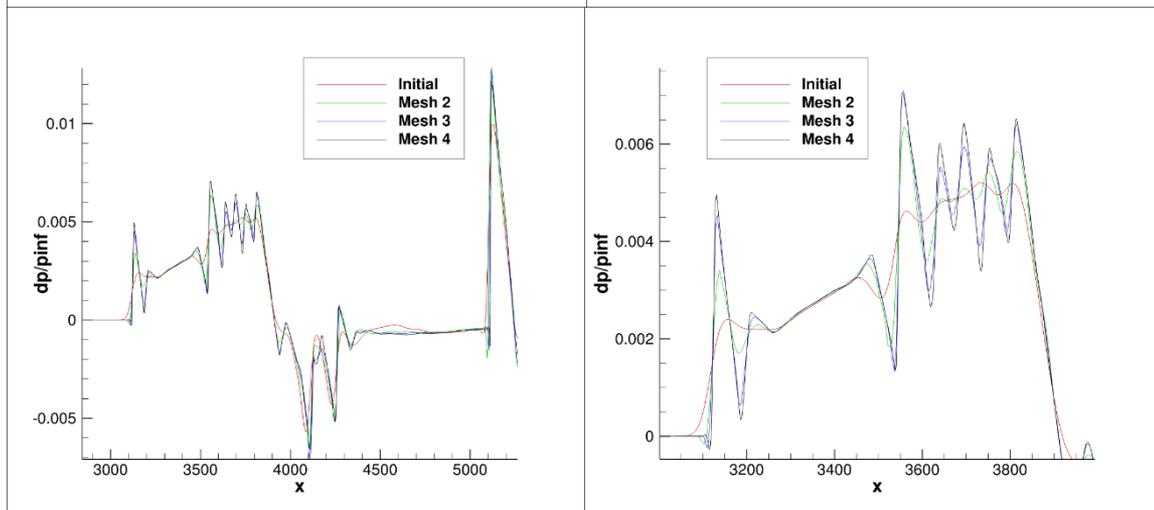
Feature-Based



Functional Grid Convergence



Output-Based



Analysis Challenges

Feature-based results did not converge functional well

- Larger grids appeared to add “noise” to the functional
- Significant trial-and-error to “tune” settings
- Large grid does not always signify adequate solution quality

Output-based results converged functional better

- Complexity schedule may improve results

Adaptation cycles limited by flow or adjoint divergence

- Adapted grids would often be problematic for primal and cause divergence

Some cases led to flow solver pursuing different solution branch